REMARKS

Claims 19, 20, 22-26, 28-39, 41, and 42 have been amended for purposes of clarification. For example, the phrase "one or more" has been added to modify various signals so as to clarify that the claims are intended to cover systems and methods that use one or more of the specified signal.

Claims 43-45 have been added, the currently pending claims are claims 1-45. Applicant respectfully submits that the claims are in condition for allowance and notification to that effect is earnestly requested. If the Examiner has any questions or concerns regarding this application, please contact the undersigned at (612) 312-2201.

If necessary, please charge any additional fees or credit overpayment to Deposit Account No. 501373.

Respectfully submitted,

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MARKED UP VERSION OF AMENDED CLAIMS

19. (Twice Amended) A method of balancing a plurality of channel currents, each of the plurality of channel currents flowing in a corresponding one of a plurality of channels in a multi-phase DC/DC converter, the DC/DC converter having an output voltage, the method comprising:

receiving a plurality of channel current signals, each of the plurality of channel current signals representative of a channel current for one of the plurality of channel currents;

averaging together the plurality of channel current signals to thereby determine [an] one or more average channel current signals;

comparing a signal representative of the output voltage to a first reference signal to thereby determine a common error signal; and

controlling each of the channel currents based at least in part on the one or more average channel current signals, one of the plurality of channel current signals, a second reference signal and the common error signal.

20. (Twice Amended) The method of claim 19, wherein controlling the channel currents comprises:

generating a plurality of pulse width modulated signals for the plurality of channels to [selectively] control the channel currents, each of the plurality of pulse width modulated signals based at least in part on the one or more average channel current signals, one of the plurality of channel current signals, the second reference signal and the common error signal.

22. (Twice Amended) A control circuit for a multi-phase DC/DC converter having an output voltage, the control circuit comprising:

an averaging circuit, responsive to a plurality of channel current signals representative of channel currents for a plurality of channels, that averages the values of

the plurality of channel current signals to produce [a] one or more signals representative of the average channel current;

an error amplifier, responsive to the output voltage and a reference signal, the error amplifier providing a common error signal; and

a plurality of pulse width modulator circuits, each responsive to the common error signal, the one or more signals representative of the average channel current, one of the plurality of channel current signals, and a second reference signal to produce a plurality of pulse width modulated signals to control the plurality of channels of the multi-phase DC/DC converter.

23. (Amended) The control circuit of claim 22, wherein the averaging circuit further comprises:

a summing circuit to add the plurality of channel current signals to produce a sum; and

a scaling circuit to produce the one or more signals representative of the average channel current from the sum.

24. (Amended) The control circuit of claim 22, [wherein each pulse width modulator circuit] further compris[es]ing:

a signal combiner circuit responsive to at least the one or more signals representative of the average channel current from the averaging circuit and [having] producing an output signal; and

[a] wherein the pulse width modulator [having] circuit has at least a first input responsive to the output signal of the signal combiner circuit.

25. (Amended) The control circuit of claim 24, wherein each pulse width modulator circuit has a second input responsive to the second reference signal.

26. (Amended) The control circuit of claim 22, [wherein each pulse width modulator circuit]further comprises:

a first difference circuit [having] producing an output signal;

[a pulse width modulator having a first input responsive to the output of the first difference circuit; and]

a second difference circuit coupled to receive an output of the averaging circuit and an associated channel current signal, the second difference circuit is adapted to output a signal that is equal to the associated channel current signal minus the one or more signals representative of the average channel current, an output of the second difference circuit is coupled to an input of the first difference circuit[.]; and

wherein the pulse width modulator circuit has a first input responsive to the output signal of the first difference circuit.

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28. (Amended) A multi-phase DC/DC converter having an output voltage comprising:

a plurality of converter channels to supply a plurality of channel currents, each converter channel having a control input and an output; and

a control circuit coupled to the control input of each converter channel to provide each converter channel with an associated pulse width modulated signal to regulate the channel current flowing through each converter channel, the control circuit is further coupled to receive channel current signals representative of the plurality of channel currents, the control circuit comprising,

a scaling circuit, responsive to the plurality of channel current signals, that produces [a] one or more scaled values based on the plurality of channel current signals,

an error amplifier, responsive to the output voltage and a first reference signal, the error amplifier providing a common error signal, and

a plurality of pulse width modulator circuits, each pulse width modulator circuit responsive to the common error signal, the one or more scaled values, one of the plurality of channel current signals, and a second reference signal to

produce a plurality of pulse width modulated signals to control the plurality of channels of the multi-phase DC/DC converter.

29. (Amended) The DC/DC converter of claim 28, wherein the scaling circuit comprises:

a summing circuit to sum up the plurality of channel current signals; and

a scaler, responsive to an output signal from the summing circuit, that produces the one or more scaled values.

30. (Amended) The DC/DC converter of claim 28, wherein the scaling circuit comprises an averaging circuit that produces [a] one or more signals representative of the average channel current signal.

31. (Amended) The DC/DC converter of claim 28, [wherein each pulse width modulator circuit] further compris[es]ing:

a signal combiner responsive to the one or more scal[ing]ed values of the scaling circuit and [having] producing an output signal; and

[a] wherein the pulse width modulator [having] circuit has a first input responsive to the output signal of the signal combiner circuit.

32. (Amended) The DC/DC converter of claim 31, wherein each pulse width modulator circuit has a second input responsive to the second reference signal.

33. (Amended) A multi-phase DC/DC converter having an output voltage, the converter comprising:

a plurality of converter channels, each converter channel having a control input to receive a control signal and an output, wherein each converter channel is adapted to output a converter channel current based at least on the control signal received at the control input of the converter channel; and

a control circuit comprising,

an error amplifier to output a common error signal, the error amplifier coupled to a first reference signal and the output voltage, a summing circuit coupled to receive channel current signals representative of the converter channel currents, the summing circuit outputting a cumulative current signal representative of the summation of the channel current signals,

a scaling circuit coupled to the summing circuit and producing [a] one or more scaled signals based on the cumulative current signal, and

a pulse width modulator for each converter channel, each pulse width modulator responsive to a combination of the one or more scaled signals, an associated channel current signal, a second reference signal, and the common error signal.

34. (Amended) The multi-phase DC/DC converter of claim 33, wherein each pulse width modulator has a first and second input, the first input of each pulse width modulator coupled to a combination of three of the one or more scaled signals, an associated channel current signal, a second reference signal and the error signal and the second input of each pulse width modulator coupled to the remaining one of the signals.

35. (Amended) The DC/DC converter of claim 34, wherein the scaling circuit divides the cumulative current signal by the number of converter channels to produce the one or more scaled signals.

36. (Amended) The DC/DC converter of claim 34, wherein the scaling circuit multiplies the cumulative current signal by a fraction to produce the one or more scaled signals.

37. (Amended) A method of balancing a plurality of channel currents of a plurality of channels in a multi-phase DC/DC converter having an output voltage, the method comprising:

receiving a plurality of channel current signals, each of the plurality of channel current signals representative of a channel current from one of the plurality of channels;

adding the plurality of channel current signals together to obtain a cumulative current signal;

scaling the cumulative current signal to obtain [a] one or more scaled channel current signals;

comparing the output voltage with a first reference signal to produce a common error signal; and

controlling each of the channel currents based at least in part on the one or more scaled channel current signals, one of the plurality of channel current signals, a second reference signal and the common error signal.

38. (Amended) The method of claim 37, wherein controlling the channel currents further comprises:

combining at least three of the, one or more scaled channel current signals, one of the plurality of channel current signals, one of the reference signals and the error signal;

applying the combination to a first input of a pulse width modulator; and

applying the remaining signal to a second input of the pulse width modulator.

39. (Amended) A method of balancing a current from a plurality of channels in a multi-phase DC/DC converter having an output signal, the method comprising:

combining a plurality of signals representative of channel currents to create a sum signal;

scaling the sum signal to create [a] one or more scaled signals;

generating a common error signal based on the output signal and a first reference signal; and

generating a control signal at each of a plurality of pulse width modulators, each control signal based on a second reference signal, an associated channel current signal, the one or more scaled signals, and the common error signal.

41. (Amended) A method of balancing current from a plurality of channels in a multi-phase DC/DC converter having an output signal, the method comprising:

generating an error signal based on the output signal and a first reference signal;

generating individual modification signals for modifying an effect of the error signal for each of the plurality of channels, each individual modification signal based at least in part on a signal representative of a channel current for the channel and [a] one or more signals representative of a scaled sum of the channel currents for the plurality of channels; and

applying the error signal and individual modification signals to a plurality of pulse width modulators for controlling the channel currents of the plurality of channels.

42. (Amended) A control circuit for a multi-phase DC/DC converter having an output voltage, the control circuit comprising:

a scaling circuit, responsive to a plurality of channel current signals representative of channel currents for a plurality of channels, that scales the values of the plurality of channel current signals to produce [a] one or more scaled signals;

an error amplifier, responsive to the output voltage and a reference signal, the error amplifier providing a common error signal; and

a plurality of pulse width modulator circuits, each responsive to the common error signal, the one or more scaled signals, one of the plurality of channel current signals, and a second reference signal to produce a plurality of pulse width modulated signals to control the plurality of channels of the multi-phase DC/DC converter.